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Development of Interactive Digital Books Based on Rme to Improve Understanding Capability Concept of Fractions For Class V Students Elementary School

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ABSTRACT

The aim of this research is to 1) determine the validity of interactive digital books based on realistic mathematics education on addition and subtraction of fractions; 2) find out the practicality of interactive digital books based on realistic mathematics education on addition and subtraction of fractions; and 3) determine the effectiveness of interactive digital books based on realistic mathematics education on adding and subtracting fractions. This research was conducted at SDN 054906 Tebasan Lama with research subjects namely class V students. This type of research is research and development with the Plomp model. The research instruments used were validation sheets, practitioner assessment questionnaires, student response questionnaires, and test instruments. The data collection techniques in this research are questionnaires and tests with data analysis techniques for testing validity, level of difficulty, discrimination and reliability for test instruments, as well as the N-Gain test. The results of this research show that 1) digital textbooks are valid, namely 98.1% (very valid) from material experts, 98.1% (very valid) from media experts, and 96% (very valid) from language experts; 2) practicality test results show that 16 out of 20 students gave very positive responses after using the product; and 3) digital books are declared effective from the analysis of learning outcomes, namely the average post-test score of students is greater than the average pre-test score, namely a score of 55 at the pre-test and a score of 88 at the post-test, classical completeness, namely in the pre-test only 15% of students completed, while in the post-test 100% of students were declared complete, and student activity, namely the final results, showed that the average percentage of student learning activity was 70% with good criteria.

Keywords*: *digital books, RME, understanding concepts

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INTRODUCTION

Education is a crucial determinant of an individual's capacity to grow and attain success in life, particularly through structured and organized learning (Adetia et al., 2025). Formal education is a structured and hierarchical type of education that is conducted in different schools (Dian Purnomo et al., 2025). Mathematics is a subject that is taught at different levels of education in Indonesia (Sugiarni et al., 2024). The objectives of mathematics education involve fostering students' cognitive abilities in mathematical thinking (Ilahy et al., 2025). Mathematics is a versatile and widely applied scientific field that holds significant importance across numerous disciplines and enhances human cognitive abilities (Kurniaman et al., 2024). Therefore, the process of gaining mathematical knowledge is anticipated to enhance pupils' cognitive capacities in logical thinking, examination, and arrangement (Kurniaman et al., 2022).

Indeed, there remains a significant number of children who encounter challenges in attaining mathematical proficiency (Kurniaman et al., 2024). The primary impediment to attaining competency in mathematics is the negative outlook of students who perceive it as the most challenging discipline to comprehend (Purba, 2019). In addition, as mentioned by Trianto, a significant issue in current mathematics instruction is the inadequate degree of pupil assimilation. As per Minister of Education and Culture Regulation Number 60 of 2014, the criteria for evaluating comprehension of mathematical concepts

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encompass: 1) the capacity to express and summarize the concepts that have been learned; 2) categorize items based on whether they fulfill the criteria that determine their importance; 3) recognize the characteristics of the process or idea; 4) employ the concept strategically. 5) Present visual representations or convey various facets of the subject under investigation; 6) Demonstrate concepts by utilizing diverse mathematical representations, including tables, graphs, diagrams, images, sketches, mathematical models, or alternative techniques; 7) Establish connections between different mathematical principles and principles from other scientific fields; and 8) Clearly state the essential and/or sufficient conditions for an idea (Febriantika, 2020).

According to the results of interviews done with class V instructors at SDN 054906 Tebasan Lama, it has been determined that students face difficulties in comprehending the taught idea of fractions. Students sometimes struggle to recall the mathematical formulas necessary to solve fraction problems. One student's response offers substantiation for this claim.

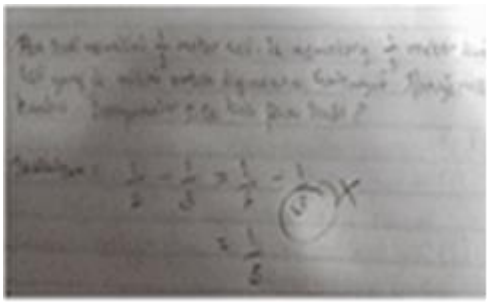

Figure 1. Student Answer Sheet

Figure 1 demonstrates that pupils still have misunderstandings when performing fraction subtraction calculations. While students demonstrate comprehension of the story problems presented by the teacher, their execution of subtracting fractions remains incorrect. This error is evident in the teacher's scribbles (Cleveland, 2007). When subtracting fractions, students should initially focus on the denominators of the two fractions. If the denominators are different, students can seek out equivalent fractions (Lalita et al., 2024). However, they should specifically search for fractions equivalent to 1/2, such as 1/6, as well as fractions equivalent to 1/3. Prior to presenting content on fraction operations, it is essential for the teacher to first cover the necessary topic of equivalent fractions. The researcher collected pre-research data on fractions from 20 students in a VA class. The data was in the form of learning results. The researcher then categorized the data based on signs of understanding mathematical ideas (Radini et al., 2025). The acquired results are as follows:

Table 1. Data on Ability to Understand Mathematical Concepts
Class VA Student at SDN 054906 Tebasan Lama

No	Indikator Kemampuan Pemahaman Konsep Matematika	Banyak Siswa yang Memenuhi Indikator	Banyak Siswa yang Tidak Memenuhi Indikator
1	Menyatakan ulang konsep yang telah di pelajari	12	8
2	Memberikan contoh atau contoh kontra (bukan contoh) dari konsep yang dipelajari	4	16
3	Mengaitkan berbagai konsep dalam matematika maupun di luar matematika	7	13

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According to table 1, the fraction questions given by the teacher align with the 3 indicators of understanding mathematical concepts. The student learning outcomes indicate that out of 20 students, only 12 were able to articulate the concepts they had learned, 4 were able to provide examples or counter examples of the studied concepts, and 7 were able to connect various mathematical concepts with concepts outside of mathematics. In order to achieve successful mathematics learning, it is necessary to actively pursue a deeper comprehension of mathematical topics (Aledya, 2019).

According to the findings of preliminary research observations conducted by researchers in class V of SDN 054906 Tebasan Lama, several facts were discovered that may be the reasons behind students' limited comprehension of the concept of fractions (Hambali et al., 2024). One of these facts is that the teacher attempted to assist students by providing teaching materials from the mathematics books used in class V, however, The teacher does not adhere to a particular learning model; instead, they employ instructional strategies like as lectures, question and answer sessions, and assignments. This results in a learning environment that is primarily focused on the teacher, known as teacher-centered learning. The textbooks currently utilized by educators and students for studying fractions fail to cultivate critical thinking skills in pupils, thereby impeding their comprehensive grasp of the notion of fractions. The fraction information included in this book is generic and does not align with the current models used by teachers to promote a thorough comprehension of the subject matter. PrototypeRealistic mathematics education (RME) is an optimal pedagogical approach for educators seeking to instruct students on the concept of fractions within the field of mathematics. This methodology, as elucidated by Nahrowi and Maulana, emphasizes the integration of students' everyday encounters into the learning process, resulting in a highly efficacious approach (Juliandara and Juhwa, 2023). Based on the explanation above, researchers conducted research aimed at developing digital-based textbooks*realistic mathematic education* which is valid, practical and effective for use by elementary school students.

METHOD

The research methodology employed is research and development, which aligns with the problem's background and research aims. According to Sugiyono (2017), research and development (R&D) refers to a set of methods employed to generate specific items and assess their effectiveness. The research design employed in this study is the Plomp design. The Plomp model has been extensively utilized in the development of mathematics teaching resources, spanning from those designed for primary schools to those intended for universities (Arnawa, Yerizon, Nita, et al., 2019). According to Plomp (1992), inquiry entails gathering and analyzing information, identifying issues, and formulating strategies for future action. The conception and design of educational research adhere to a methodical, iterative process that includes analysis, design, assessment, and revision activities. These activities are repeated in order to strike a balance between expected outcomes and actual accomplishments. The following is an overview of the research methodology.

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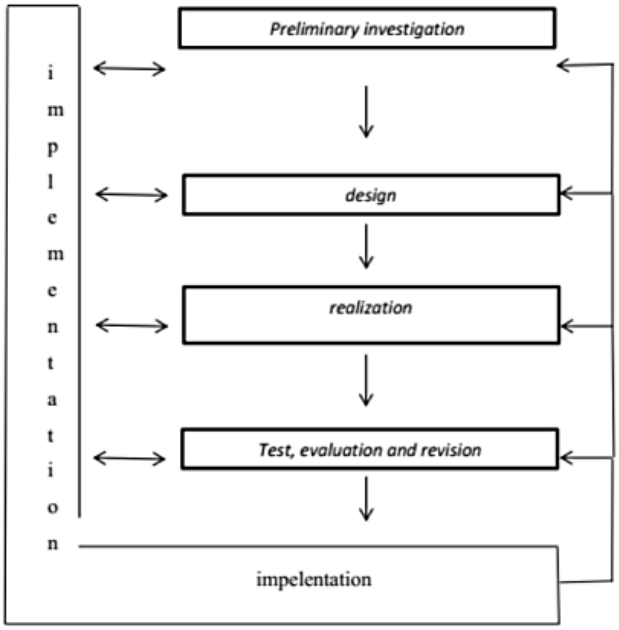

Figure 1. Plomp Development Research Procedures

Research stages or steps serve as a framework for conducting research, allowing for adjustments to meet unique needs, resulting in a more focused, systematic, and structured implementation process.

1) Investigation Phase (*Prelimenary Investigation*). At this stage, researchers collect data or information in the field, identifying problems related to mathematics teaching materials in fifth grade elementary school.
2) Design Phase (*Design*) This stage represents the process of designing a product. The product design process begins with creating a conceptual design, followed by developing content that will be included in the final product.
3) Realization/Construction Phase (*Realization/Cnstruction*) At this stage the basic shape of the product is produced as a result of the realization of the design phase. At this stage, digital books begin to be developed according to the design that was designed at the design stage.
4) Test, Evaluation and Revision Phase (*Test, Evaluation, and Revision*) This stage is testing, evaluation, and revision of products that have been previously realized. The final result of this stage is a product in the form of an interactive digital book containing mathematical material based on the RME approach. The product must meet the appropriateness standards for a learning device, namely valid, practical and effective. Therefore, at this stage validation activities are carried out by experts.
5) Implementation Phase (*Implementation*) After testing the product is successful and there may be further revisions, then the product in the form of learning media will be applied within a wide range of educational institutions.

The research and development project was conducted in SDN 054906 Tebasan Lama, situated on Jalan Pendidikan Tebasan Lama, Pantai Gemi, Kec. Stabat, Kab. Langkat Prov. North Sumatra. This study involved 25 students from class VA SDN 054906 Tebasan Lama who served as participants for product testing. The research and development period will take place during the odd semester of the 2023/2024 academic year, commencing in July 2023 and concluding in December 2024.

Researchers utilized devices as a means to facilitate data collecting during the data collection procedure. The researchers employed instruments that were modified to align with the specific data gathering

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methodologies utilized. For instance, questionnaires were used for product validation, whereas test instruments took the form of essays. Researchers acquire data through the process of data collection. Once all the data has been gathered, the researcher can proceed with data analysis. Data analysis procedures are tailored to suit the specific characteristics of the data. The scoring of product validity data was modified to a Likert scale, while the analysis of the test utilized the n-gain test.

RESULTS AND DISCUSSION

Research Result

In this research, a device development model is used which refers to the development of Plomp which consists of 5 stages, namely initial assessment (*preliminary investigation*), planning (*design*), realization/construction (*realization/construction*), test, evaluation, and revision (*test, evaluation, and revision*), and implementation (*implementation*). These stages are described as follows:

1. Preliminary study level (*preliminary investigation*)

The preliminary inquiry phase is conducted to identify the fundamental issues required for the development of educational resources. During this phase, an examination of the curriculum, student demographics, and instructional materials is conducted. The initial observations indicate that the school is using the 2013 Curriculum. However, the teaching methods employed by the teachers do not align with the learning models emphasized in the 2013 curriculum, such as Realistic Mathematics Education (RME). Additionally, the only learning tool being used is a printed class V mathematics textbook. In addition, students' intellectual ability in comprehending the concepts of adding and subtracting fractions vary. Students study the fraction content, namely KD 3.1 and 4.1.

2. Planning Level (*Design Phase*)

Referring to the indicators developed according to previous basic competencies, the material planned to be discussed in the textbook is fraction counting operations. The material is presented according to the syntax*Realistic mathematics education* namely 1) situation, namely at this stage students read and understand contextual problems related to the rules for adding and subtracting fractions; 2) model of (model of), namely the teacher appoints one of the students to mention a possible example of the problem presented using a model or picture that represents the problem; 3) model for (model for), namely students write down all the possibilities that can occur from the problem given in the form of pictures or certain patterns; and 4) formal mathematics, namely students make conclusions from the activities they have carried out so that students can find formulas regarding the rules for adding and subtracting fractions.

The digital textbook developed is in the form of a flipbook so that students can still feel the sensation of opening a book via smartphone. In the flipbook there are several learning videos, this design was made with the aim that students can learn independently at school and at home with more fun and more easily understand the concept of adding and subtracting fractions.

3. Realization/construction stage (*Realization/Construction Phase*)

Making products in the form of digital books in flipbook form is adjusted to the material design and product design plans at the design stage. The following is the product realization.

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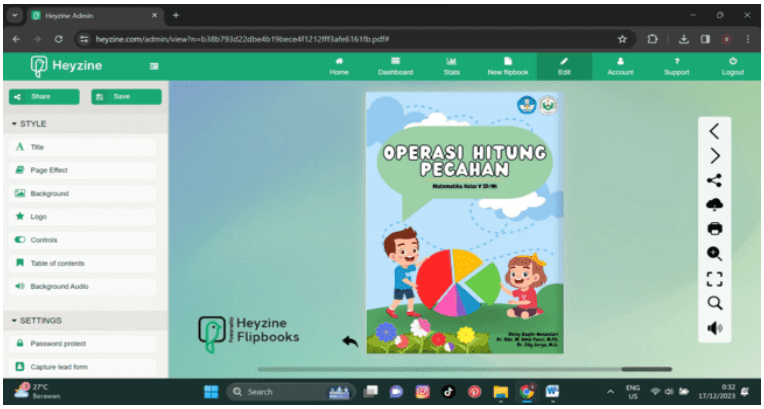

Figure 2. Digital Book Display

4. Test, Evaluation and Revision Stage (*Test, Evaluation, and Revision Phase*)

The next step in development research is the validation process which includes product assessment and revision. Validation in this research is divided into two categories, namely test instrument validation and product validation. The test instrument validation results show:

a. Testing the test essay instrument using product moment correlation with a total of 20 questions and a degree of freedom of 18 resulted in 11 of the 20 test essay questions being declared valid, while the other 9 questions were declared invalid.
b. The level or level of difficulty of a question must be tested to find out whether the question item is included in the easy, medium or difficult category. According to Bagiyono (2017: 03), a learning outcome evaluation item is declared good if the item is neither too difficult nor too easy. The difficulty level test of 11 valid questions shows that there are 3 easy questions, 8 medium questions, and 0 difficult questions. . Thus, from the 11 valid essay questions, 5 essay questions were selected consisting of 2 easy questions, namely numbers 3 and 11, and 3 medium questions, namely numbers 2, 10, and 14.
c. The discriminating power test on 5 selected questions showed that 4 questions had sufficient discriminating power, namely item numbers 2, 3, 10, and 14, and only 1 question had poor discriminating power, namely item number 11.
d. The reliability test of the test instrument in this study has a value of 0.82 or $\alpha > 0.7$, which means that the test instrument is declared to have high reliability.

The product creation process and instrument validation tests that have been carried out previously produce digital textbook products along with data collection instruments, namely questionnaires and tests. This process includes initial activities, the next step is to validate the product. The purpose of product validation is to find out how valid or to what extent the product being developed meets user needs. The results of product validation by material, media and language experts are.

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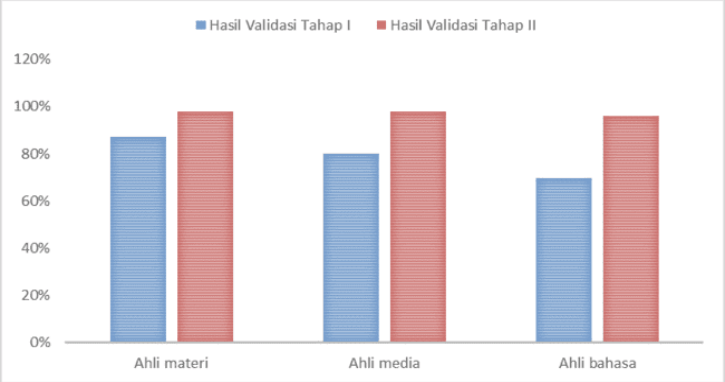

Figure 3. Recapitulation of Product Validation Results

The initial validation conducted by the material validator yielded a score of 87.2%, indicating that the product was deemed highly valid. However, some minor adjustments are still required to enhance the applicability of the indicators and the method of practical mathematical instruction. The second validation was conducted following the change. The results of the second phase of material validation were 98.1%, indicating that the product was deemed very valid without requiring further revision. Meanwhile, the media validators have determined that 80% of the product has passed the media validation process. However, adjustments are required as there are still some areas that need improvement. After the revision, a second validation was conducted. The findings of the second stage of media validation showed a 98.1% accuracy rate, placing it in the very valid category. Therefore, the product can be used without any more revisions. Subsequently, the language validator's initial evaluation yielded a 70% validity rating for the product. However, further adjustments were deemed necessary, particularly in relation to linguistic norms. Following the adjustments made in response to the complaints and suggestions mentioned earlier, a second validation was conducted. The findings of this language validation, as assessed by the validator, indicated a 96% accuracy rate, placing it in the very valid category. Consequently, the product can be used without the need for further revisions.

5. Implementation (*Implementation*)

Basically, statements related to increasing students' ability to understand mathematical concepts can be proven through the N-Gain test from the pre-test and post-test results of class V students who have been given treatment. The following are the results of the N-Gain test.

Table 2. Recapitulation of N-Gain Test Results

Range	Improvement Category	The number of students	Percent age
$N \geq 0,7$	Height	15	75%
$0,3 \leq N \leq 0,7$	Currently	5	25%
$N < 0,3$	Low	0	0%

Based on the table above, it is known that 75% of students experienced a significant increase in their ability to understand mathematical concepts or were in the high category, while the other 25% were in the

medium category and there were no students who did not experience an increase in their ability to understand the concept of adding and subtracting fractions in class V.

Discussion

Realistic mathematics education (RME) is an instructional approach that emphasizes the conceptual understanding of mathematical concepts and promotes student engagement in the learning process. The primary advantage of RME is its capacity to offer students a distinct and pragmatic comprehension of the relationship between mathematics and daily existence, as well as the broader application of mathematics in human life. The RME learning methodology can be applied either through direct instruction or integrated with traditional textbooks. Mathematics textbooks can be developed by teachers who focus on syntax-based learning.Realistic mathematics education (RME) is an approach to teaching mathematics that aims to make the subject more practical and applicable to real-life situations. The creation of this textbook can facilitate students' comprehension of mathematical ideas and ensure long-lasting retention.

The use of the Plomp model development stages resulted in the creation of a digital mathematics textbook on fractions that was both valid and very practical. An electronic book, generally referred to as an e-book, is a digital version of a textbook. According to Martha, an e-book is a digital version of a book that typically includes a compilation of content (Rarastika, 2023). An advantage of e-books is their ability to facilitate pupils' access to material in jpeg format. The move from mv3 to mv4 entails a change from the format observed in the physical textbooks utilized by students during class. On the other hand, mv4 may be conveniently accessible through smartphones, allowing students to engage in independent study from the comfort of their homes.

CONCLUSIONS AND RECOMMENDATION

The research findings and discussion indicate that an interactive digital book product was developed that successfully meets the criteria for product feasibility. These criteria include:
1) The interactive digital book has been validated by experts in media, material, and language; 2) The practicality of the interactive digital book has been confirmed by class V teachers and has received highly positive feedback from class V students who have used it; and 3) The interactive digital book has been found to be effective. This can be observed through the learning outcomes of students who achieve the minimum competency level (KKM) after receiving treatment in the form of utilizing interactive digital books for realistic mathematics teaching. Therefore, fifth grade educators can utilize the interactive digital book, which has been created as a supplementary educational tool, to teach students about the concepts of adding and subtracting fractions in the classroom. Furthermore, this interactive digital book can serve as a valuable reference for future researchers who aim to develop similar digital books covering different subject matter.

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